ExxonMobil

Jayflex™ Plasticizers Together, Stronger, Further

Flexible PVC – made to last

SAVA Conference

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Andrés Vargas

Principal Plasticizer Technology

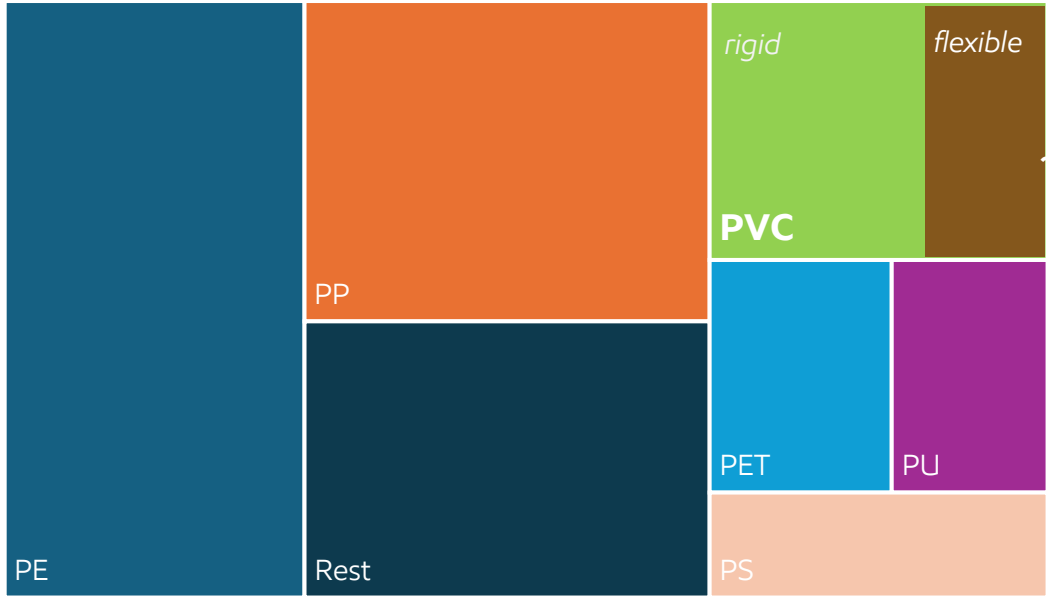
The Big Picture

Global demand – Flexible PVC and Plasticizers

~360Mt[a]
Global plastic resin demand

~50Mt[b]
Global PVC demand

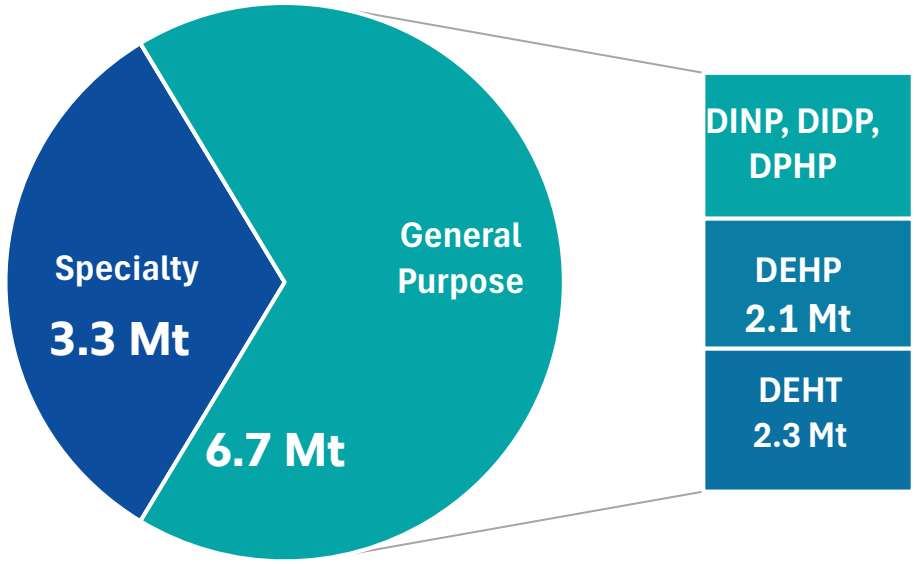
~15Mt[b]
PVC demand for flexible applications



~10Mt[c]
Plasticizer global demand

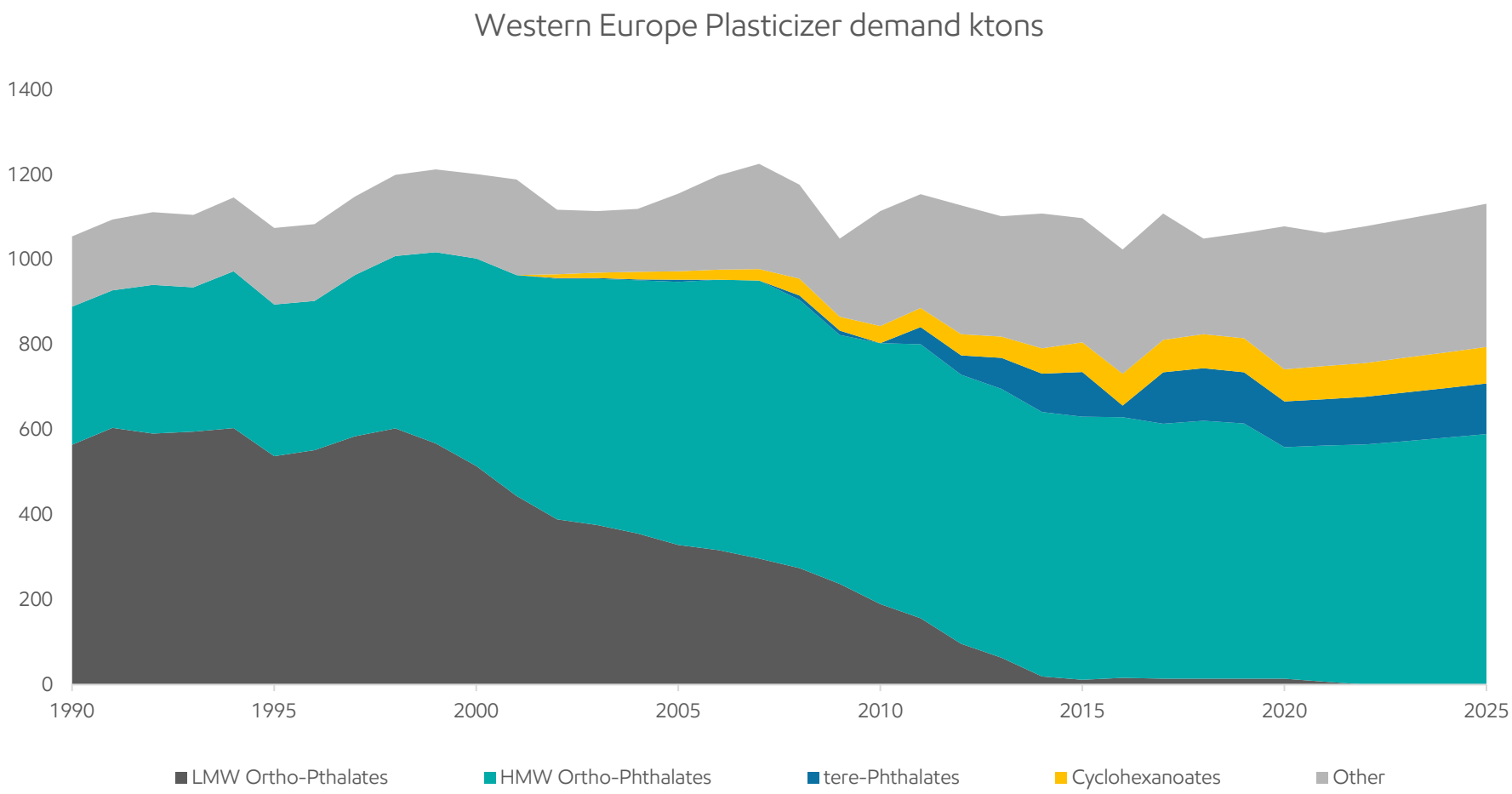
~6.7Mt[c]
General Purpose plasticizers

~2.3Mt[c]
General Purpose High Molecular Weight – Ortho phthalates (DINP, DIDP, DPHP)



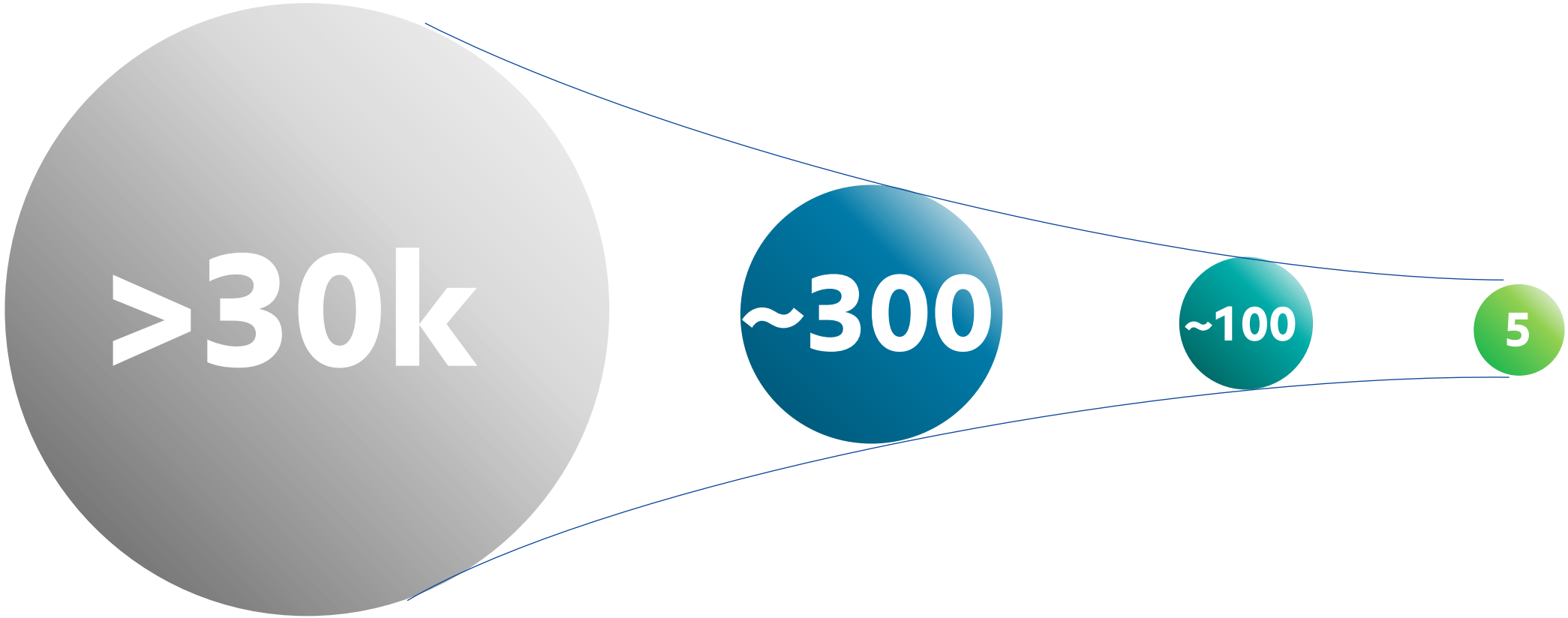
a. *Plastics Europe 2022 report.(Note: Report includes additional ~30 kt of recycled plastics)*
b. *S&P Global Commodity Insights, © 2022 by S&P Global Inc CEH- IHS PVC Resins report 2022 and ExxonMobil assessments*
c. *S&P Global Commodity Insights, © 2024 by S&P Global Inc CEH- IHS Plasticizers report 2024 and ExxonMobil assessments*

Mature region shift to HMW phthalates



Source: IHS Chemical Economics Handbook 2015 report – Plasticizers -S&P Global Commodity Insights, © 2024 by S&P Global Inc CEH- IHS Plasticizers report 2021

+90 years of industrial plasticizer use



Substances studied and tested as plasticizers

Plasticizers launched to market

Plasticizers in use today

Only 5 general purpose plasticizers

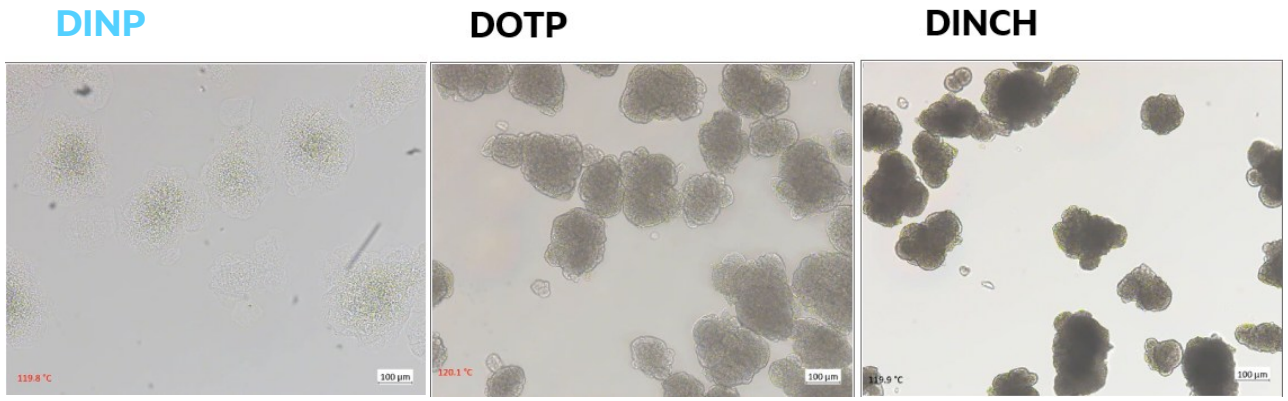
Together...

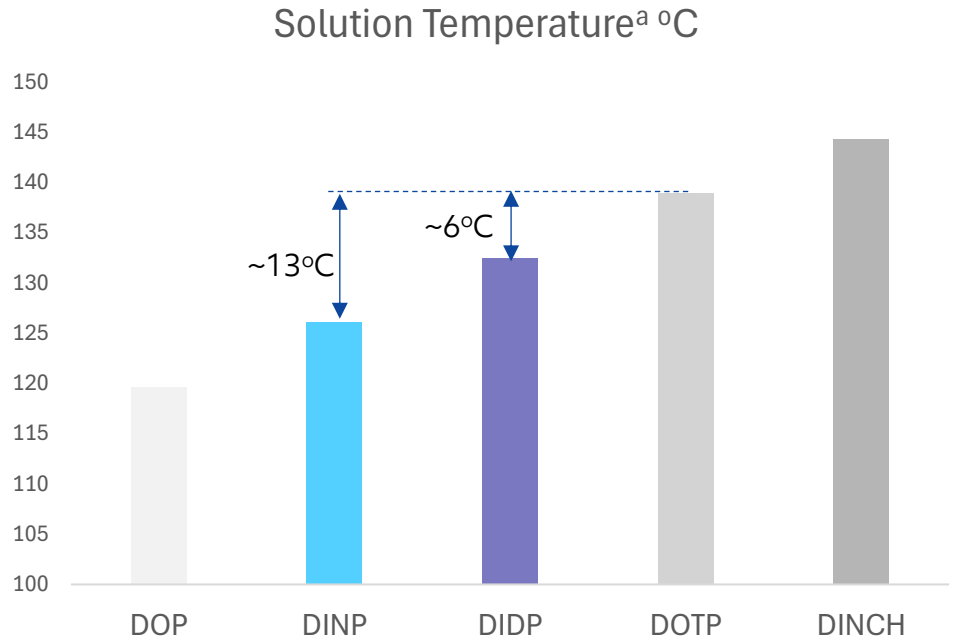
In world that never stands still, no one can face tomorrow's challenges alone

Compatibility – PVC solubility in plasticizer

DINP and DIDP show better affinity

Solution Temperature[a], microscope images @ 120°C





Solution temperature compares solvency power
→ affinity of plasticizer with PVC

Lower solution temperature
→ more affinity of the plasticizer with PVC

Contributes to
- Lower plastisol gelation temperature
- Faster dry blend absorption time

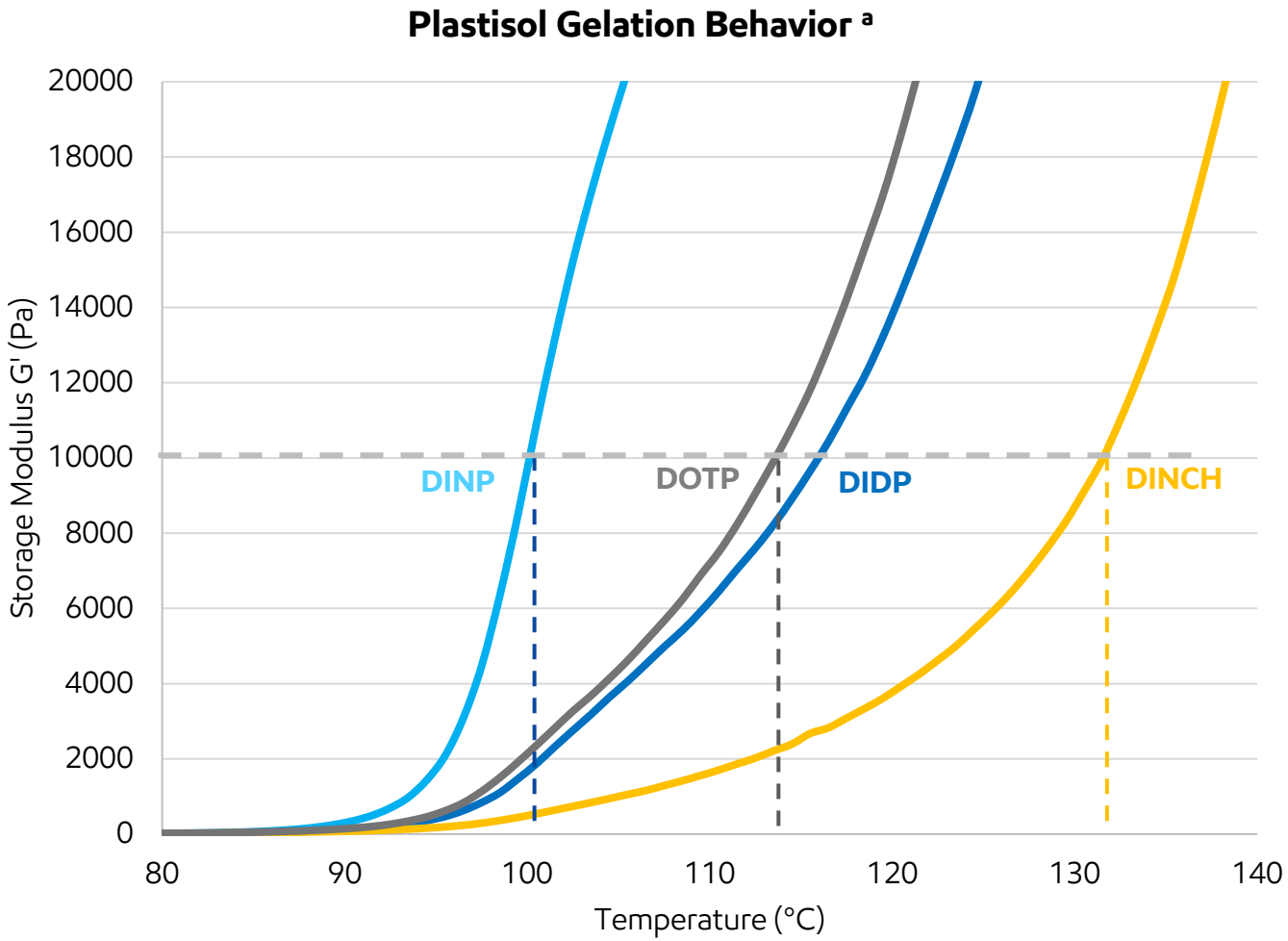
Data from tests performed by or on behalf of ExxonMobil

[a] Solution Temperature – ExxonMobil Method TM-186981 48g of plasticizer and 2 grams of PVC

Processing Advantages of DINP - Gelation

DINP requires less heat to gel
which can enable lower operation temperatures or faster processing

- DINP requires less heat to transition from viscous liquid to gel phase
- Dry touch temperature (gelation temperature) is a plastisol key processing parameter.



Data from tests performed by or on behalf of ExxonMobil

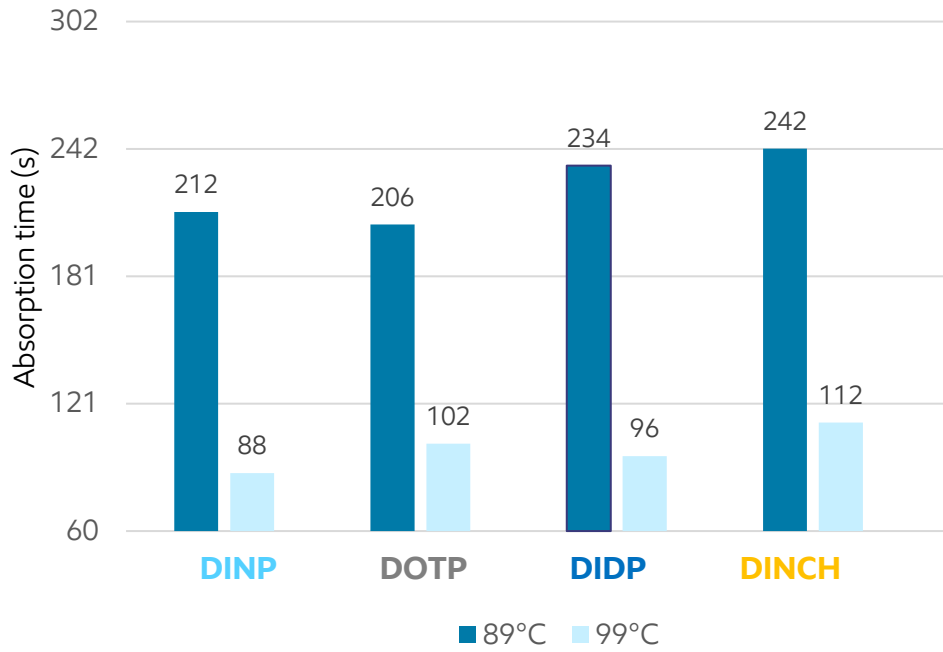
[a] ExxonMobil test method: TM-186930 Plastisol gelation. Equipment Physica MCR101. Compound formulation: E-PVC 100 phr; plasticizer 60 phr

Processing Advantages: dry-blending absorption time

DINP shows low dry-blend absorption times
enabling faster processing

- DINP has faster dry-blend time at higher processing temperature
- DIDP has faster dry blend time than DINCH and comparable to DOTP at high processing temperature

Plasticizer absorption time [a]
at efficiency



Dry blending time is a function of plasticizer viscosity and compatibility with PVC.

Data from tests performed by or on behalf of ExxonMobil

Compound formulation: S-PVC (K-value 71) 100 phr; plasticizer 53 phr DINP; 55 phr DIDP, DPHP (ie. at efficiency); filler 40 phr; stabilizer 5 phr
[a] ExxonMobil Method OMP-185794 Brabender - 435 g PVC + fillers + stab are added to the mixer and heated to the set temperature. Mixer speed 120 rpm. Plasticizer is added after ± 5 min. Max torque and drop-off time are recorded.

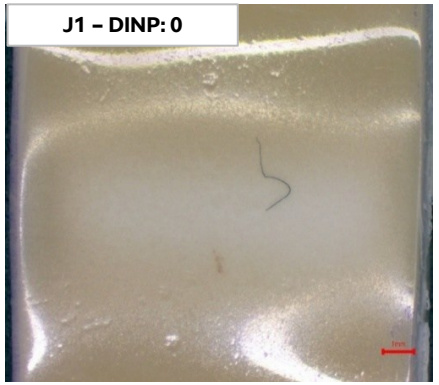
Compatibility – Plasticizer exudation from compound

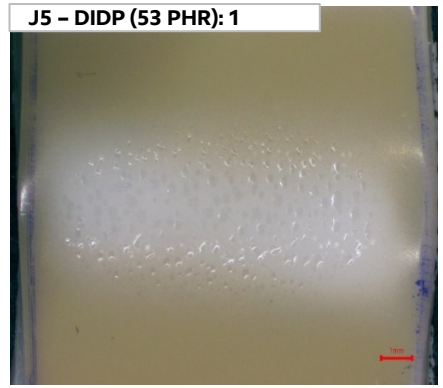
DINP and DIDP show lower exudation

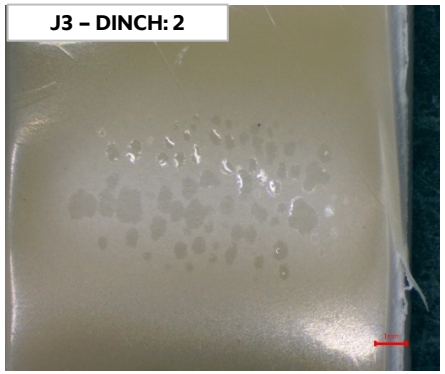
Loop Test[a] : Plasticizers in compounded PVC				
	Loop Test 48 hr	Loop Test 1 day	Loop Test 7 days	ASTM D3291[b] 7 days
DINP	0	1	0	0
DIDP	0	1	1	0
DINCH	0	2	0	-
DOTP	1	2	3	3

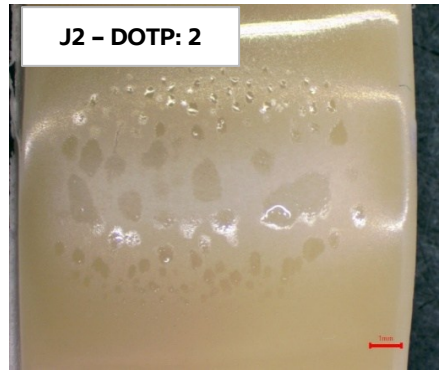
	Descriptions
0	No exudation
1	Very faint and discontinuous exudation
2	Moderate exudation.
3	Heavy exudation

Exudation examples









Lower exudation (lower Loop Test Value):

- Better plasticizer permanency under mechanical stress

→ no blooming to the surface over time or under folding

- Better compatibility

→ no paint de wetting or bleeding

Data from tests performed by or on behalf of ExxonMobil

[a] ExxonMobil Test method: TM-186961 Formulation PVC (271PC) 100 phr, DINP/DINCH/DOTP 50 phr, other plasticizers to efficiency: DIDP 53 phr, DPDHP 53 phr, DIUP 55 phr, filler 50 phr, stabilizer 4 phr

[b] The Technology of Plasticizers, Sears and Darby, John Wiley & Sons New York, 1982. Chapter 1 F. Standard Industrial Plasticizers, Chapter 6 Permanence of Plasticized PVC, Appendix: Table A6 Plasticizer performance in Plasticized PVC (DINP 53PHR, DIDP 55 PHR, DOTP, 54PHR)

Stronger...

High Molecular Weight phthalates DINP and DIDP help you formulate smarter, and your flexible PVC perform better, last longer and meet safety standards worldwide

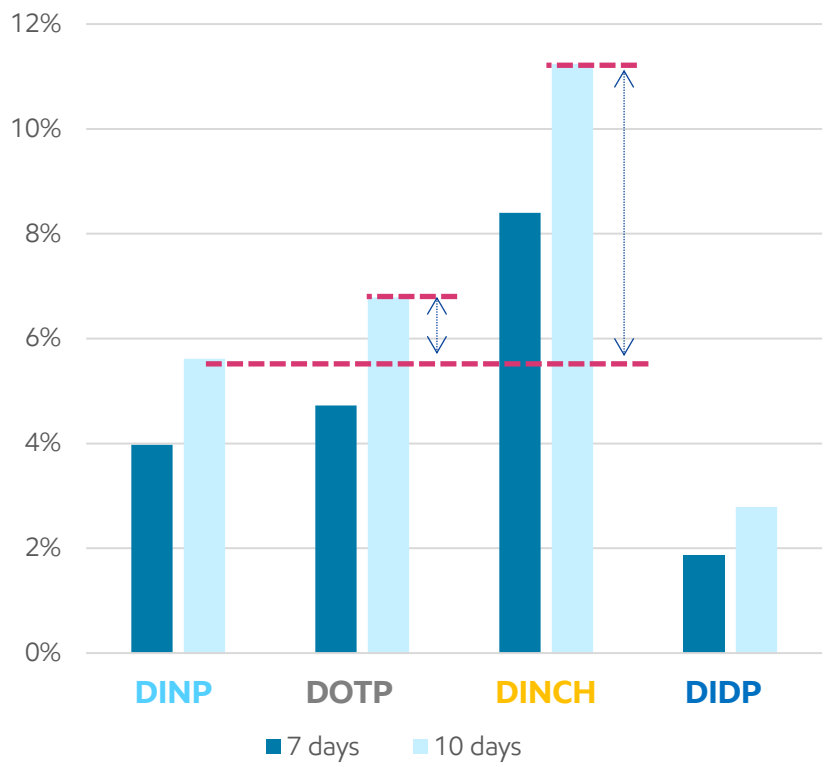
Performance advantages of DINP and DIDP

DINP and DIDP better retained mechanical properties for longer service life of your products

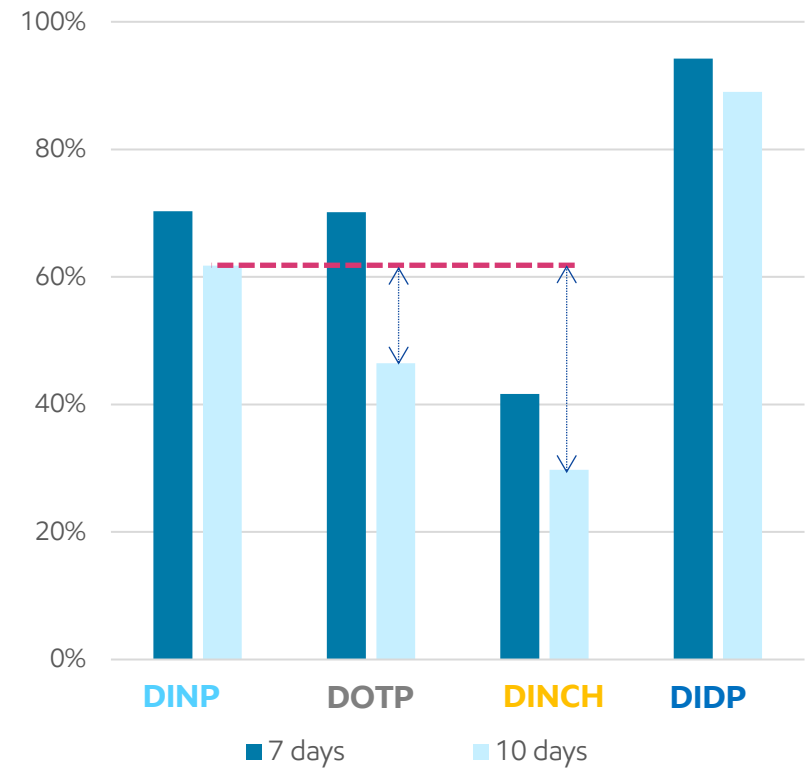
After severe accelerated aging DINP and DIDP show:

- Lower volatilization loses
- Closer to original mechanical properties
- Better permanency

Weight Loss (%) - Forced Ventilation @100 °C[a]



Retained Elongation @ Break (% vs original) - Forced Ventilation @100 °C[a]



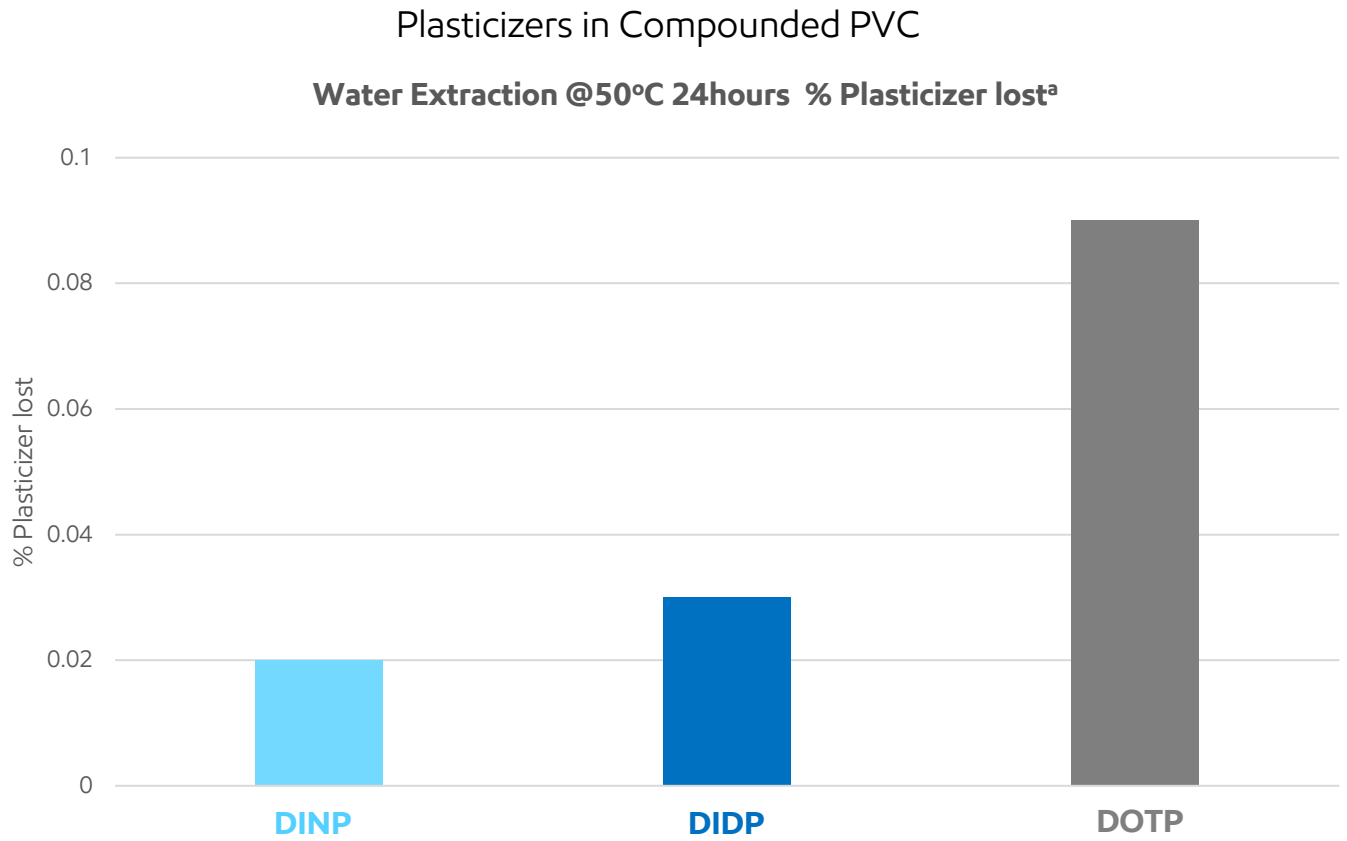
Data from tests performed by or on behalf of ExxonMobil

[a] Retained properties – ExxonMobil Method TM-186966 – Forced Ventilation at 100 °C. Specimens prepared according to ASTM 638. Compound formulation: S-PVC (K-value 71) 100 phr; plasticizer 50 phr DINP, DOTP, DINCH / 53 phr DIDP, DPHP (ie. at efficiency); filler 50 phr; stabilizer 4 phr..

Performance advantages of DINP and DIDP

Water extraction shows higher permanency of DINP

- DINP extremely low solubility in water, tightly bound into compounded PVC



[a] The Technology of Plasticizers, Sears and Darby, John Wiley & Sons New York, 1982. Chapter 1 F. Standard Industrial Plasticizers, Chapter 6 Permanence of Plasticized PVC, Appendix: Table A6 Plasticizer performance in Plasticized PVC

DINP provides volume cost savings

Case study: 3D laminated PVC film

Film with 100 phr PVC / 30 phr plasticizer Width 53" (1.346 m) / Gauge 12 mil (0.305 mm)	Plasticizer level (phr)	DOP **30**	DINP **30**
	Formulation density (g/cm^3)	**1.276**	**1.271**
Number of additional meters of films produced with **1 MT compound**	# of meters	**=**	**+ 7**
Adjusting plasticizer level for the same Hardness Shore A level:	Plasticizer level (phr)	DOP **30**	DINP **31**
	Formulation density (g/cm^3)	**1.276**	**1.268**
Number of additional meters of films produced with **25 MT plasticizer truck**	# of meters	**=**	**+ 3913**

Volume (liters) = weight (g) / density (g/liters) ← → Length (flexible film) = volume / thickness * width

Further...

For more than 80 years since ExxonMobil first patented HMW phthalates DINP and DIDP we have been with you co-innovating, securing supply reliability and navigating evolving regulations

Regulators support that all phthalates are not the same

Ortho-Phthalates

DEHP
BBP
DBP
DIBP

→ **Low MW ortho-phthalate**

ECHA EUROPEAN CHEMICALS AGENCY

- **Classified as Cat 1B Reprotoxicants**
- **Regulated as SVHCs, subject to authorization**

DINP*
DIDP*
DIUP
DTDP

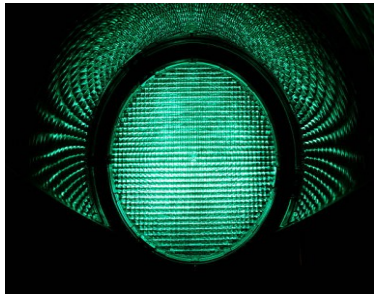
→ **High MW ortho-phthalate**

ECHA EUROPEAN CHEMICALS AGENCY

- **EU CLP – Not classified**
- **US CPSC – Safe in toys (DIDP)**
  - **US CPSC – Safe MoE (DINP)**
- **Health Canada – "low risk"**
- **Australia NICNAS – no toy restrictions**

Health Canada

Australian Government
Department of Health
National Industrial Chemicals Notification and Assessment Scheme

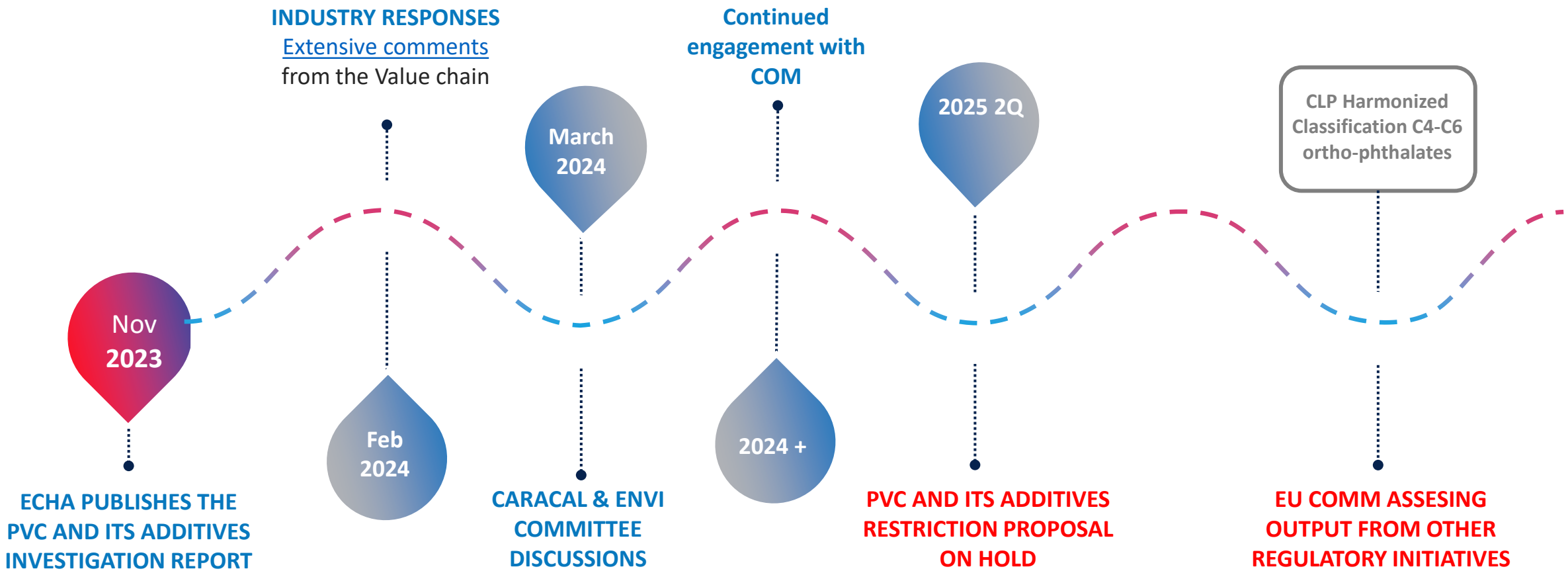


Regulatory status
Dec. 2024

*Precautionary restrictions toys and childcare articles that can be placed in the mouth DINP (US, EU, CA), DIDP (EU, CA)

EU – ECHA update

Constant dialogue with authorities to promote sound science

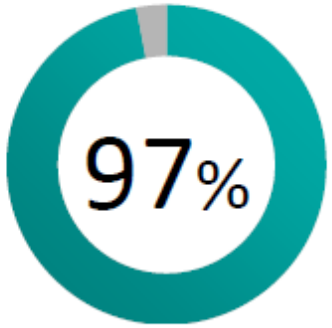


US-EPA TSCA MRRE Outcome

SAFE FOR USE[1]:

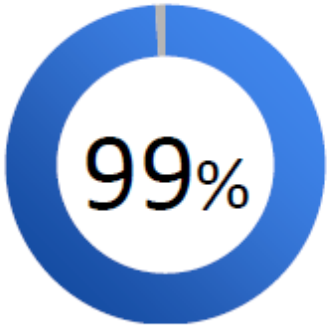
- For consumers
- For general population
- For the environment

DINP



43 uses out of 47 safe,[2] representing 97% of production, **EPA has concluded safe use**

DIDP



43 uses out of 49 safe,[3] representing 99% of production, **EPA has concluded safe use**

A further assessment confirming safe use

1 Including sensitive sub-populations such as women of child-bearing age, infants, children and the elderly.

2 DINP uses identified as presenting an unreasonable risk to workers: Industrial spray-applied (i) adhesives and sealants, and (ii) paints and coatings. DINP uses identified as posing an unreasonable risk to workers include industrial spray-applied (i) adhesives and sealants, (ii) paints and coatings, as well as commercial spray-applied (iii) adhesives and sealants, and (iv) paints and coatings applications.

3 DIDP uses identified as presenting an unreasonable risk to workers include spray-applied industrial uses in (i)adhesives and sealants, and (ii) paint and coatings, as well as spray-applied commercial uses in (iii) adhesives and sealants, (iv) paint and coatings, (v)lacquers, stains, varnishes, floor finishes, and (vi) inspection fluids or penetrants.

*The 3% and 1% in white in the DINP & DIDP pies correspond to the volume of each substance dedicated to applications listed under footnotes number 2 and 3, respectively.

Together,
Stronger,
Further...

Customers value the advantages of DINP

Application: Vehicle sealants and underbody coatings

***Faster** and **lower** gelling temperature vs. alternative plasticizers:*

- *Baking temperature **lower** by more than30°C*
- *Gelling temperature start reduced by more than 10°C*
- *Reduction of 2 ovens in OEM paint shop*

Compatibility

- *Better paint **compatibility** 4WET (wet on wet cures in 1 oven)*
- *DINP shows no bleeding vs alternatives, due to **compatibility***
- *Alternative plasticizers show paint de-wetting*
- ***Compatible** with all plastisol raw materials avoiding plastisol waste*

Other

- *Density reduction, allowing lower plastisol weight per car*
- *Lower Volatile hydrocarbon solvents in plastisol*
- *Plastisol less water diffusion providing better protection to EV vehicle batteries*

Customers value the advantages of DINP

Application: Waterproofing membranes / roofing

DINP is our main PVC plasticizer. Compared to similar alternative molecules like DOTP and DINCH, ***DINP was proven to remain in the matrix*** *(no leaching) in artificial and real weathering, making it:*

- ***safer*** *for the environment and*
- ***increasing the lifetime*** *of the PVC membranes*

PVC membranes plasticized with DINP

- *can be recycled into PVC membranes without loss of performance*
- *can last up to 30 years when directly exposed to external environmental agent, and more than 50 years when not exposed directly*

Application: Coated fabrics

Currently we use DINP for about 95% of our products. most of our fabrics are fully exposed to the elements and therefore need to have ***excellent outdoor weathering properties****, both UV and hydrolysis resistance (e.g. pool covers, tent, sport mats, textile architecture, pergolas and truck tarps.*

We observe poor adhesion with DOTP and other para-phthalates, they have too many free alcohols inhibit glue additives (required for good adhesion) and have worse gelation behavior.

General purpose plasticizer compared performance

DINP and DIDP:

are safe for use as intended, outperform alternatives, offer optimal balance of performance, safety and cost

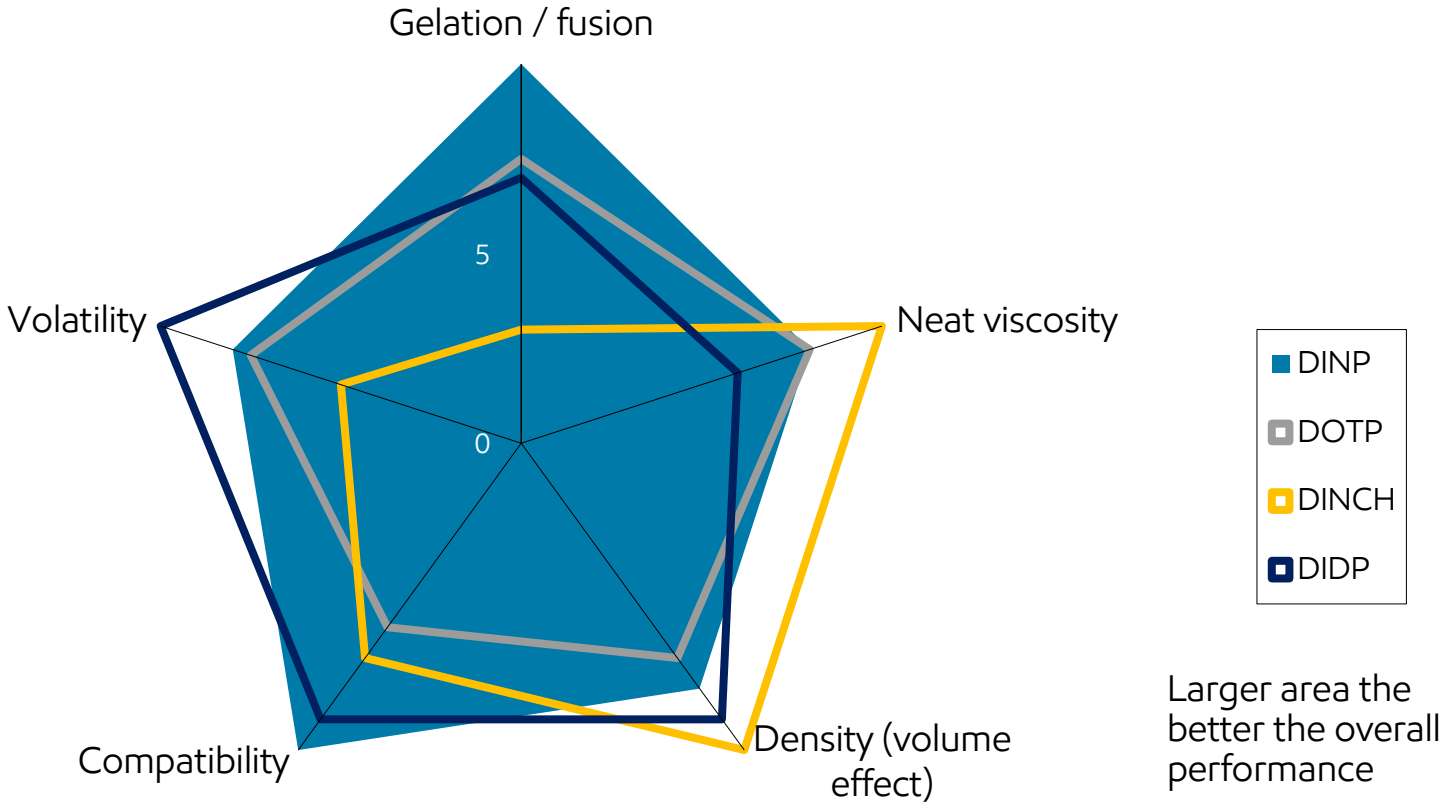
Benefits

DINP

- Higher compatibility with PVC
- Faster plastisol gelling
- Faster dry blend time
- Better retained mechanical properties

DIDP

- Lower volatility
- Significantly enhanced retained mechanical properties
- Higher compatibility with PVC



Larger area the better the overall performance

Source: Based on ExxonMobil tests and assessments and published literature

Thank you!

ExxonMobil

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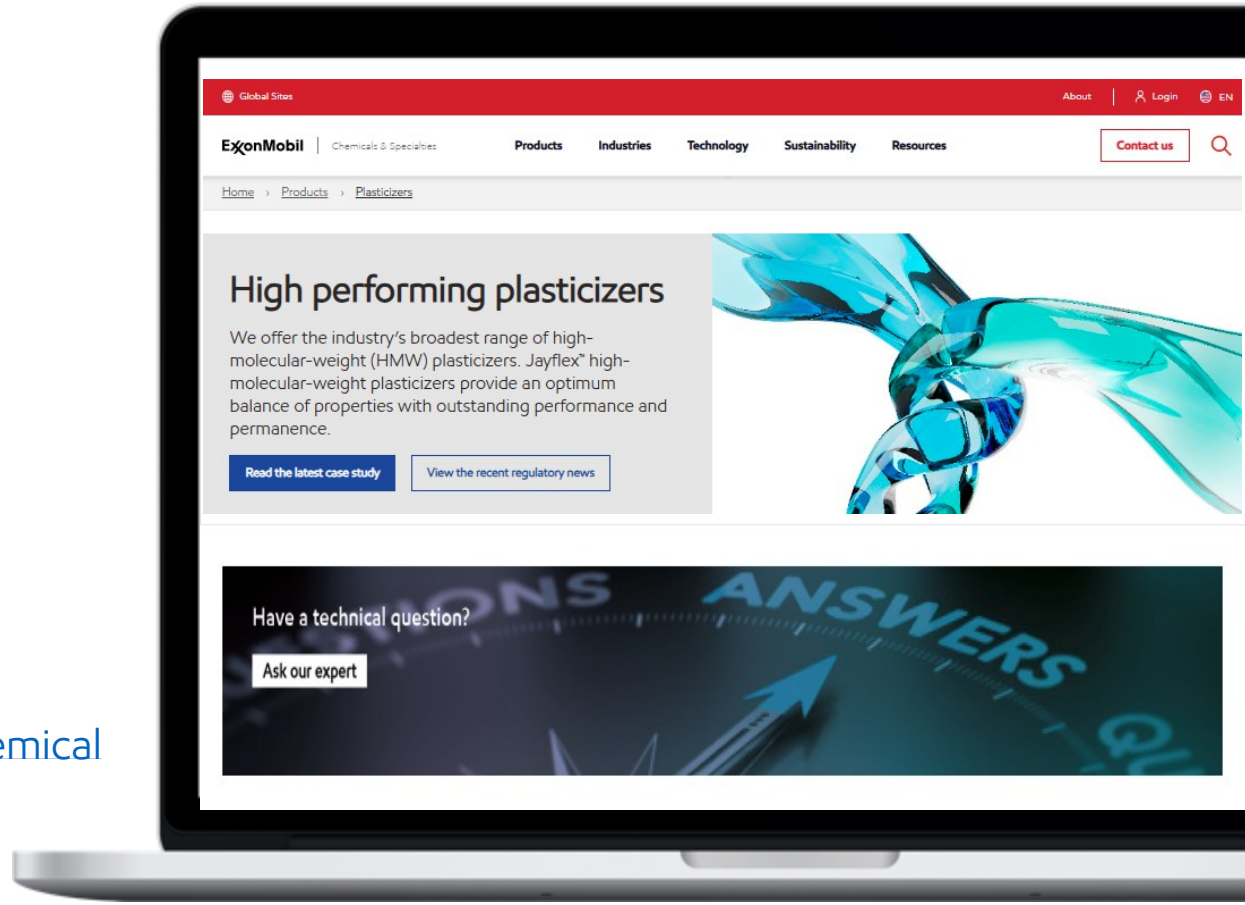

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